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***Adlafia diahotensis*, sp. nov. (Bacillariophyceae), a new species from New Caledonia**

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ABSTRACT

During a survey of epilithic diatoms in the running water of the main island of New Caledonia, a new species was found: *Adlafia diahotensis* Le Cohu, Marquié & Tudesque, sp. nov. This species is characterized by the valve outline with ends wedge shaped obtusely rounded. In light microscopy, the striae are only discernible in the center of the valve. In scanning electron microscopy, the internal proximal raphe endings are shortly deflected towards the primary side of the valve and far apart from each other.

KEY WORDS

Adlafia,
New Caledonia,
ultrastructure,
new species.

RÉSUMÉ

Adlafia diahotensis, sp. nov. (Bacillariophyceae), une nouvelle espèce de Nouvelle-Calédonie.

Lors du suivi des diatomées épilithiques des eaux douces de l'île principale de Nouvelle-Calédonie, une nouvelle espèce a été découverte : *Adlafia diahotensis* Le Cohu, Marquié & Tudesque, sp. nov. Cette espèce se caractérise par le contour des valves aux extrémités cunéiformes abruptement arrondies. En microscopie optique, les stries sont seulement visibles au centre de la valve. En microscopie électronique, en vue interne, les extrémités proximales du raphé sont légèrement incurvées vers le côté primaire de la valve et sont éloignées l'une de l'autre.

MOTS CLÉS

Adlafia,
Nouvelle-Calédonie,
ultrastructure,
espèce nouvelle.

TABLE 1. — Comparison of features between *Adlafia diahotensis* Le Cohu, Marquié & Tudesque, sp. nov. and the most related taxa.

Taxa	Valve outline & dimensions (length and width, μm)	Shape of end	Central area	Stria density (per 10 μm)	Reference
<i>Adlafia diahotensis</i> , sp. nov.	Linear-lanceolate to almost elliptical — 9.5-16.0; 2.8-3.8	Wedge-shaped obtusely rounded	Lacking	36-40	This paper
<i>A. langebertalotii</i> Monnier	Linear-lanceolate to elliptic lanceolate — 7.3-11.9; 2.0-2.6	Non protracted rounded	Lacking	30-32	Monnier <i>et al.</i> 2012
<i>A. djibaoui</i> Marquié	Linear 8.5-14.5; 3.0-3.5	Narrowly rostrate to shortly protracted	Lacking	42-44	Marquié <i>et al.</i> 2018
<i>A. suchlandtii</i> Lange-Bertalot; Monnier	Linear to linear-elliptic	Cuneately narrowed with obtusely rounded apices	Almost non existing	26-28	Lange-Bertalot 2001; Monnier <i>et al.</i> 2012

INTRODUCTION

The genus *Adlafia* Moser, Lange-Bertalot & Metzeltin was established from the neocaledonian *A. muscora* (Kociolek & Reviers) Moser, Lange-Bertalot & Metzeltin as the type of the genus (Moser *et al.* 1998). In light microscopy (LM), the species of this genus are difficult to distinguish from other related genera such as *Kobayasiella* Lange-Bertalot but scanning electron microscopy (SEM) information offers better evidence. According to Lange-Bertalot (in Moser *et al.* 1998), Morales & Le (2005), Monnier *et al.* (2012), some features of the genus can be detailed: 1) external areolae occluded; 2) filiform raphe weakly curved with distal endings deflected in the same direction; 3) axial area very narrow with a central area variable but never expanded to reach the valve margin; 4) stria density usually high with a clearly radiate striation pattern becoming abruptly convergent towards the valves apices and 5) striae uniseriate running continuously from the valve face to the mantle. So far, the genus includes 29 species (Liu *et al.* 2017; Marquié *et al.* 2018; Guiry & Guiry 2019).

The island of New Caledonia is very famous for its unparalleled plant endemism, partly due to its ultramafic soils (Jaffré *et al.* 2009; Morat *et al.* 2012). According to Moser (1999), it is the same for the diatom flora. Recently, two new species of *Adlafia* (Marquié *et al.* 2018) and three new species of *Delicata* Krammer (Le Cohu *et al.* 2018) were described. Since the last genus was invalidated (Wynne 2019) with a new generic designation under the name of *Delicatophycus* Wynne (Le Cohu *et al.* 2019).

In 2012 and 2013 a survey of the epilithic diatom flora in the running waters of New Caledonia was initiated in the framework of the water quality monitoring. A new species was discovered: *Adlafia diahotensis*, sp. nov. The present paper describes the new species based on light (LM) and especially on scanning electron microscopy (SEM) investigations. A comparison is made with the most similar taxa (Table 1).

MATERIAL AND METHODS

The studied material of epilithic diatoms comes from the river Diahot. *Adlafia diahotensis*, sp. nov. was found in a sampling

site bordered by a riparian vegetation and located upstream Paimbous village. The substrate was composed of rocks and pebbles. The Table 2 summarizes the physico-chemical parameters at the sample site.

Diatom samples were oxidized with hydrogen peroxide, rinsed three times with demineralized water and mounted in Naphrax. LM analysis was performed with an Olympus BX 51 in Nomarski mode with an SC 30 digital camera. For SEM examination, cleaned diatoms were dried onto coverslips attached to aluminum stubs using nail varnish. The stubs were coated with 5 nm of platinum (Leica EMMED 020, Vienna) and observed with a FEG FEI Quanta 250 (Eindhoven, Holland). Diatom terminology follows Round *et al.* (1990).

RESULTS

Adlafia diahotensis

Le Cohu, Marquié & Tudesque, sp. nov.
(LM, Fig. 1A-T; SEM, Figs 1U-W, 2)

HOLOTYPE. — PC0576263, National Museum of Natural History, Paris, France.

ISOTYPE. — BR-4540, National Botanical Garden of Belgium, Meise, Belgium.

TYPE LOCALITY. — River Diahot upstream of Paimbous village. Longitude: 164.566917, latitude: -20.527133.

ETYMOLOGY. — In reference to the river where the species was sampled.

DESCRIPTION

LM

Valves linear-lanceolate to almost elliptical, ends wedge-shaped obtusely rounded (Fig. 1A-T). Length: 9.5-16 μm ; width: 2.8-3.8 μm (N>50). Axial area linear. Raphe filiform weakly lateral with proximal endings slightly expanded. Striation best visible in the middle of the valve where it is radial.

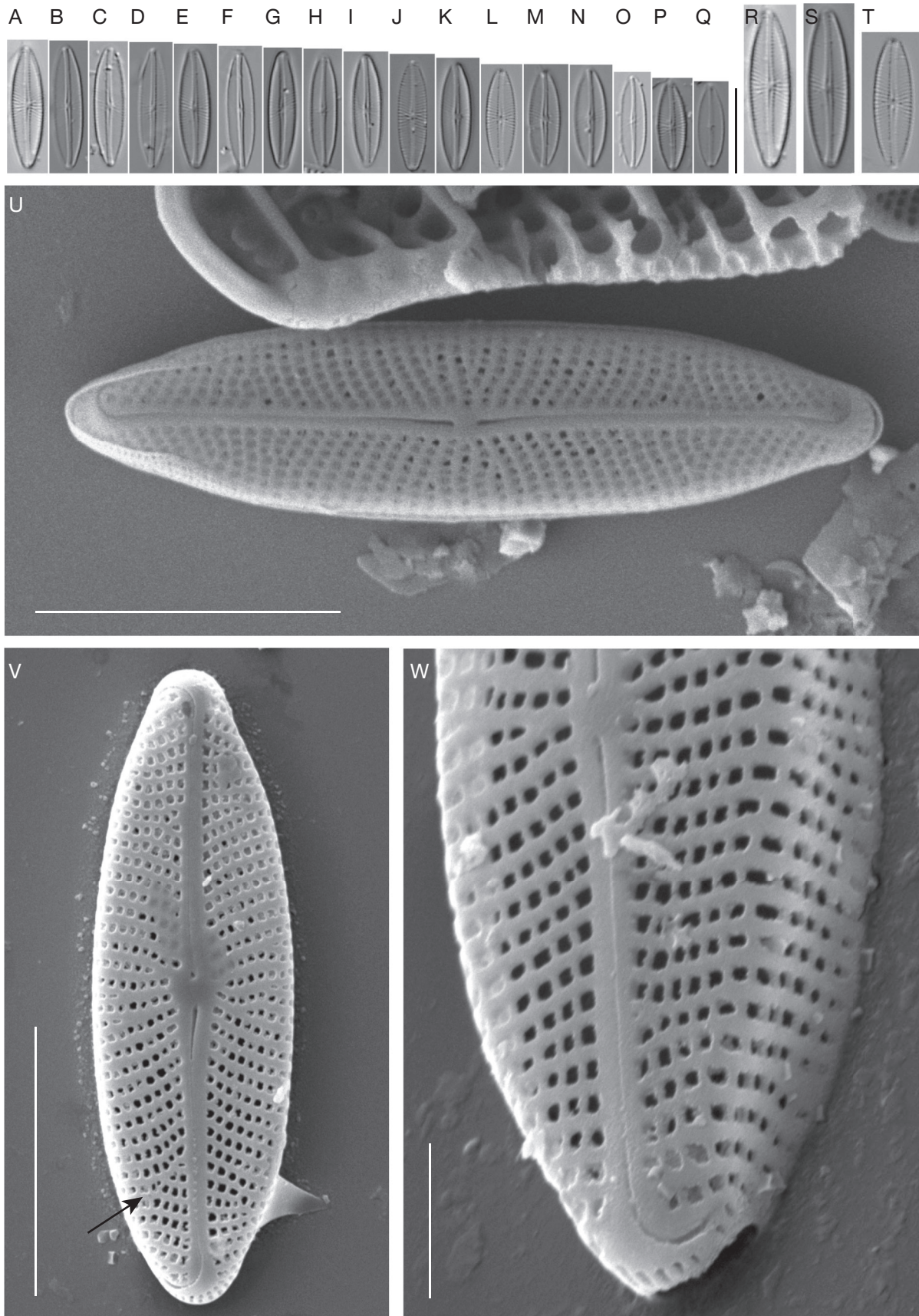


FIG. 1. — *Adlafia diahotensis* Le Cohu, Marquié & Tudesque, sp. nov.: **A-T**, LM. Range in valve outline and size; **U-W**, SEM; **U**, external view showing the occluded areolae; **V**, external view showing the strong discontinuity (Voigh fault) in stria direction (**arrow**); **W**, half valve showing striae running continuously from the valve face to the mantle. Scale bars: A-Q, 10 μ m; R-V, 5 μ m; W, 1 μ m.

TABLE 2. — Physico-chemical characteristics of the water from Diahot river.

	Long.	Lat.	T (°C)	pH	Cond µS.cm ⁻¹	NH ₄ mg.L ⁻¹	NO ₃ mg.L ⁻¹	PO ₄ mg.L ⁻¹	Fe mg.L ⁻¹	Ni mg.L ⁻¹	Ca mg.L ⁻¹	Si mg.L ⁻¹	Na mg.L ⁻¹	Hg mg.L ⁻¹
Diahot River	164.5669	-20.5271	27.0	8.4	48.0	0.008	0.0	0.029	0.11	0.0	2.2	8.2	4.6	0.99

SEM

Axial area narrow hardly widened in the middle of the valve. Externally, raphe fissures slightly laterally displaced towards the secondary side of the valve (Fig. 1U, V); proximal raphe endings weakly curved towards the primary side; terminal fissures hooked, partly curved backward and terminating at the junction valve face-mantle (Fig. 1V, W). Internally, raphe slits straight with proximal endings shortly and slightly deflected in the same direction (Fig. 2A, B); distal endings terminating in small helictoglossae laterally extended by a siliceous thickening corresponding to the terminal fissures (Fig. 2A, B, arrowheads). Intermissio present with proximal raphe endings far apart from each other (Fig. 2A, B). Striae uniseriate (36-40 in 10 µm), radiate, becoming abruptly convergent approaching apices and continuing onto the mantle (Fig. 1W); shift in the orientation of the striae generally marked by a bifurcate stria on either side of the valve (Figs 1V; 2A, B, arrows); striae composed of quadrangular areolae externally occluded (Fig. 1U). Around the central area, presence of two short striae with often one of them only consisting of two areolae (Figs 1U, V; 2A, B). Cingulum consisting of at least two open cingular bands (Fig. 2C, D). Two rows of poroids on the valvocopula, one poroid located on the pars interior and only visible in dismembered frustules while the other is visible on exterior pars (Fig. 2C, D[vc, c]).

COMMENTS

Due to possible misidentification in LM with other *Adlafia* species, especially *A. djibaoui* Le Cohu, Marquié & Coste (Marquié *et al.* 2018), the occurrence of *A. diahotensis* is not clearly known. In the locality type, the diatom flora is relatively diversified (38 taxa identified). The major accompanying species include species such as *Adlafia muscora* (16%), *Navicula suprinii* Moser, Lange-Bertalot & Metzeltin (9.5%), *Achnanthisidium catenatum* (Bily & Marvan) Lange-Bertalot (9.3%), *Gomphonema brasiliense* Grunow spp. *pacificum* Moser, Lange-Bertalot & Metzeltin (7.5%). 13 species are endemic, that is to say more than 25% of the recorded diatom taxa. The river is very poor in nutrients (Table 2).

DISCUSSION

Adlafia diahotensis, sp. nov. belongs to the genus *Adlafia* based on the characteristic features of the genus: areolae externally occluded and internally open, a strong discontinuity in the stria direction near the apices, striae running uninterruptedly from valve face to mantle and low valve dimensions (Lange-Bertalot 2001). *Adlafia diahotensis*, sp. nov. shows some similarities

with the neocaledonian *A. djibaoui* Le Cohu, Marquié & Coste and *A. langebertalotii* Monnier & Ector (Monnier *et al.* 2012) and *A. suchlandtii* (Hustedt) Lange-Bertalot. *Adlafia diahotensis*, sp. nov. and *A. djibaoui* can be differentiated by the morphology, the apices being cuneate in *A. diahotensis* whereas they are narrowly rostrate or shortly protracted in *A. djibaoui*. Moreover the stria number is different (36-40 vs 42-44 in 10 µm) and the internal proximal raphe endings are more distant from each other in *A. djibaoui* Le Cohu, Marquié & Coste than in *A. diahotensis* (around 0.36 vs 0.25 µm). *Adlafia diahotensis*, sp. nov. and *A. langebertalotii* can be separated by the stria number (36-40 vs 30-32 in 10 µm) and the stria pattern around the central area. Concerning *A. suchlandtii*, the stria number is significantly lower than in *A. diahotensis* (Table 1).

Recently, Marquié *et al.* (2018) have noticed that the genus *Adlafia* can be divided in two groups. The first one includes species with internal proximal raphe endings straight such as *A. frenotii* Van de Vijver, Ledegank & Beyens, *A. bryophiloides* (Manguin) Van de Vijver (Van de Vijver *et al.* 2002), *A. submuscora* Van de Vijver, Kopalova, Zidarova & Cox (Van de Vijver *et al.* 2013) and *A. moseri* Marquié, Le Cohu & Coste (Marquié *et al.* 2018).

The second group includes the species with internal proximal raphe endings deflected towards the primary side of the valve such as the neocaledonian generitype *Adlafia muscora*, *A. multinomahii* Morales & Le (2005), *A. langebertalotii*, *A. sinensis* Liu & Williams (Liu *et al.* 2017), *A. decora* Tusset, Tremarin & Ludwig and *A. triundulata* Tusset, Tremarin & Ludwig (Tusset *et al.* 2017), *A. djibaoui* (Marquié *et al.* 2018) and *A. diahotensis* (in this study). Marquié *et al.* (2018) have suggested the use of the length of the intermissio as a supplementary criterion to separate the *Adlafia* species. This proposal should be considered with a great deal of precaution; indeed the length differences of the intermissio are very often not significant between the species. Some example of species highlight the difficulties to use the length of the intermissio: 0.4 µm, 0.48 µm, 0.53 µm, 0.5 µm for *A. langebertalotii*, *A. sinensis*, *A. multinomahii*, *A. decora*. By contrast, this proposal can be relevant in other cases; for example *A. djibaoui* and *A. diahotensis* have a length intermissio (0.25 µm; 0.35 µm) significantly different from the species cited above. This assumption needs further accurate SEM investigations.

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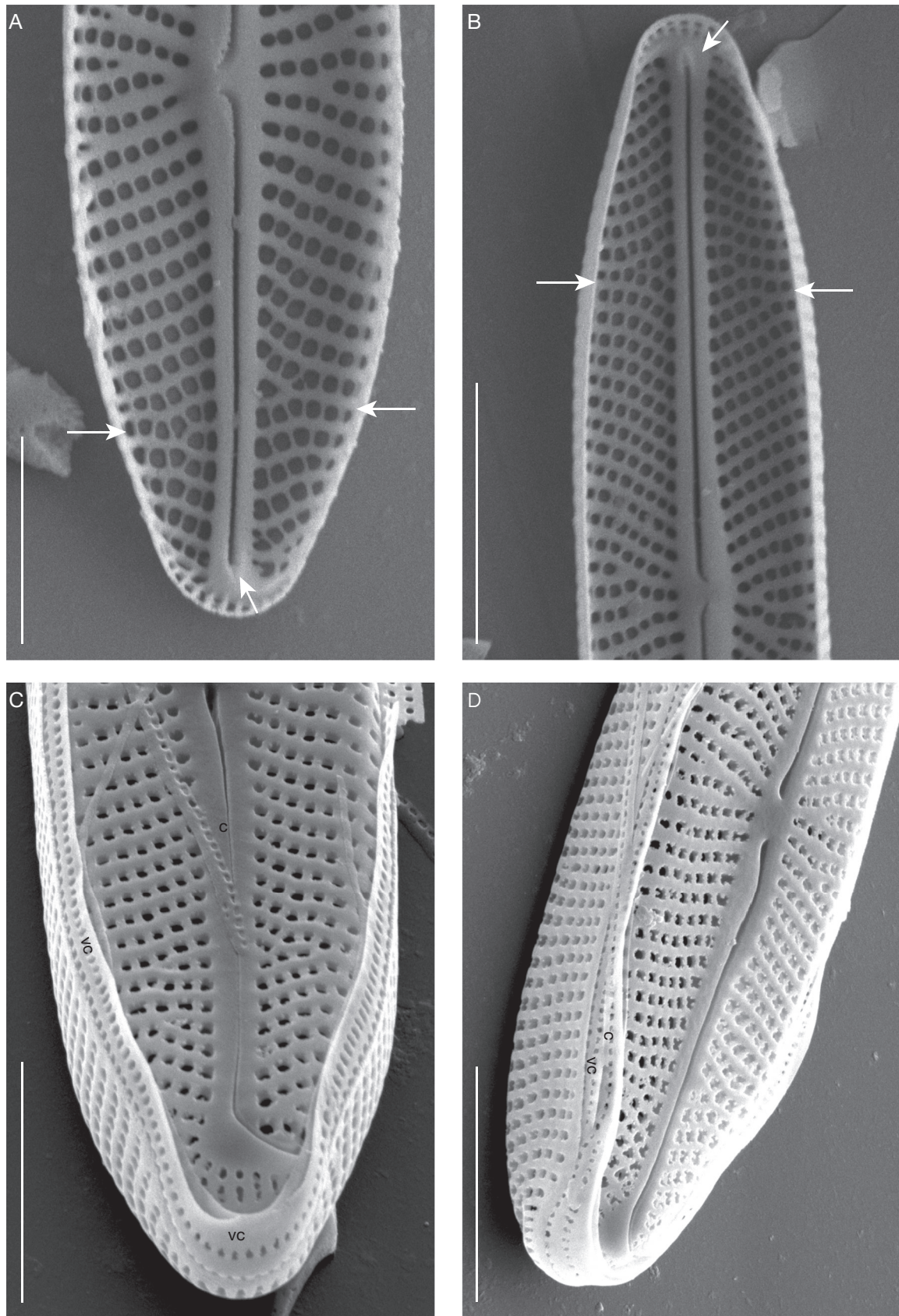


FIG. 2.— *Adlafia diahotensis* Le Cohu, Marqué & Tudesque, sp. nov., SEM: **A, B**, internal views of an half valve showing the shift in the striae orientation marked by a bifurcate stria (**arrows**), the distant internal proximal raphe endings deflected to the primary side and the helictoglossa laterally extended by a siliceous thickening (**arrowhead**); **C**, external view showing a valvocopula (**vc**) and the end of a copula (**c**); **D**, tilted external view with the end of a valvocopula (**vc**) and a copula (**c**). Scale bars: A, C, 2 μ m; B, D, 3 μ m.

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